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Digital resonant laser printing: manipulating optical meta-elements on demand

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Realized by micro and nanofabrication technologies, nanophotonics has offered the control of light with nanoscale metallic or dielectric elements. One popular demonstration is optical metasurfaces, which rely on the ability to precisely control its individual meta-elements on the optical surfaces. By spatial control over light, metasurfaces allow for engineering scattering spectra as well as the optical wave-fronts of the output light sheet.

We developed a digital resonant laser printing (DRLP) technique as a flexible post-writing technology for mass-customization of optical metasurfaces. Strong on-resonance energy absorption under pulsed laser irradiation locally elevates the lattice temperature of individual meta-atoms in an ultra-short time scale. This was demonstrated for both metallic [1], and high-index dielectric metasurfaces [2]. In the DRLP process, rapid melting allows for surface-energy-driven morphology changes and sintering/annealing of individual meta-elements with associated modification of amplitude, phase and polarization of the reflected and transmitted light from the metasurface. By controlling of the DRLP process, we can manipulate the meta-elements on demand and with a very high precision. Combined with the use of pre-fabricated large-area metasurface templates, DRLP is a promising approach for next-generation low-cost optical devices for advanced applications.

[1] X. Zhu, C. Vannahme, E. Højlund-Nielsen, N.A. Mortensen, A. Kristensen Plasmonic colour laser printing, Nat. Nanotechnol., 11 (4) (2016), pp. 325-329, 10.1038/nnano.2015.285.

[2] X. Zhu, W. Yan, U. Levy, N.A. Mortensen, A. Kristensen Resonant-laser-printing of structural colors on high-index dielectric metasurfaces, Sci. Adv., 3 (5) (2017), p. e1602487, 10.1126/sciadv.1602487.